# §79. Stray Radiation Behavior Measured at Different Locations in the LHD Vacuum Vessel

Igami, H., Kubo, S., Laqua, H.P. (IPP Griefswald), Nagasaki, K. (IAE, Kyoto Univ.), Inagaki, S., Shimozuma, T., Notake, T., Yoshimura, Y., Mutoh, T.

Monitoring of the stray radiation with so-called sniffer probes 1) is helpful to confirm the effectiveness of electron cyclotron heating (ECH) absorption. If the level of the stray radiation with plasma is low as compared with that without plasma, we can guess that the injected microwave power is absorbed in the plasma. A sniffer probe consists of a stainless steel oversized wave guide antenna coupled to a spherical copper cavity. The diameter of the wave guide is several times of the vacuum wavelength, allowing many modes to propagate. All incoming waves into the integrating cavity are nearly equally coupled to the microwave detecter after several reflections 1). Two sniffer probes are installed in different locations in the LHD vacuum vessel as shown in Fig.1 (a). One is installed in a horizontal port (2-O) and the other is installed in a bottom port (9.5-L). We changed 84GHz microwave beam focal point on the "target plane" on the midplane as shown in Fig.1(a) and (b), to search the good focal point to excite electron Bernstein waves (EBWs) in the over-dense plasma via O-X-B mode conversion process. In the over-dense plasma, the electron density exceeds the plasma cutoff density near the electron cyclotron resonance (ECR) layer. 270 kW microwaves were injected with 100% power modulation at 47 Hz into the target plasma sustained by 5.1 MW neutral beam injection (NBI). The magnetic configuration was $R_{axis}$ = 3.6 m, $B_{axis}$ = 2.75 T. Nearly O- and X-mode were injected. The line averaged electron density at the central code exceeded the cutoff density, $n_c$ = 8.98 $10^{19} m^{-3}$ during the superimposed injection. In Fig.2 (a)-(f), the stray radiation levels at each probe are plotted for three different cases as a function of the toroidal focal point. Note that both cases of $R_{focal}$ = 3.91 m, and 3.94 m are included at $T_{focal}$ = −0.78 m. When the microwave beam was injected toward the focal point A, into the over-dense plasmas, the average of the stray radiation at the 2-O sniffer probe became minimal and the modulation profile of the electron temperature suggests that power absorption took place. While, the average at the 9.5-L sniffer probe did not vary significantly with changing the focal point. In the experiment, the over-dense plasma often collapsed during the discharge. As shown in Fig.2 (b), when microwaves were injected into the collapsing plasmas the stray radiation levels were high at the 2-O sniffer probe. While, the levels at the 9.5-L sniffer probe were as low as the case of the injection into the over-dense plasmas When microwaves were injected into the vacuum, the stray radiation levels were not as high as in the cases of the injection into the collapsing plasmas at 2-O sniffer probe, while at the 9.5-L sniffer probe, the stray radiation levels are higher than the cases of injections into over-dense plasmas and collapsing plasmas. These tendency can be explained as follows. The incident microwave beam passes close to the 2-O port. If an over-dense plasma exists in the vacuum chamber, the injected microwaves are reflected at the cutoff point in the plasma and large amount of the reflected power almost comes back around the 2-O port, except when the microwave beam successfully excite EBWs. The 9.5-L port is located in the opposite direction of the microwave beam direction. Therefore the stray radiation picked up at the 9.5-L sniffer probe may be the integration of the residual microwaves through multi reflection. When a plasma exists, the power of microwaves are gradually absorbed every time the waves are reflected on the wall and pass through the plasma. Even if the waves do not suffer the single path absorption, large portion of the injected power is absorbed in the plasma before the waves reach the sniffer probe at the 9.5-L port.

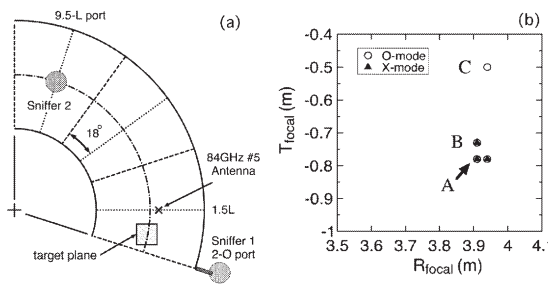


Fig. 1: (a) Positional relationship between the microwave beam injection antenna and the sniffer probes. (b)Experimental focal point setting plotted within the target plane drawn in Fig.1(a).

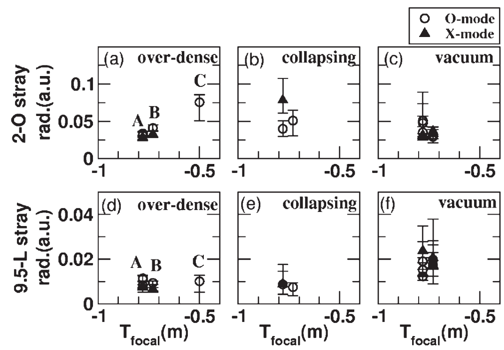


Fig. 2: Signal level of the stray radiation at the 2-O and 9.5-L sniffer probes for each case of injection into (a)(d) over-dense plasmas, (b)(e) collapsing plasmas and (c)(f) the vacuum space. Focal points A, B and C correspond to those plotted in Fig.1 (b)

References

1) Gandini F et al., 2001, *Fusion Eng. Des.* **56-57** p.975-979